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Acoustic Properties of Affiliative Vocalizations That Promote Individual Recognition in Squirrel Monkeys

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INTRODUCTION

Adult female squirrel monkeys (*Saimiri* spp.) that are socially familiar are known to exchange the "chuck" vocalization in antiphonal sequences. Previous observations and playback experiments in captivity show that females can discriminate between the chucks of conspecific individuals. The chucks of closely affiliated partners are answered more than those of nonaffiliated group members; the chucks of (affiliated and nonaffiliated) familiar group members are answered more than unfamiliar chucks from strangers; unfamiliar chucks from strangers are most likely answered if they are acoustically similar to familiar group chucks; and all chuck stimulus classes are usually answered more than silent controls. In this study, we analyze the acoustic properties of chucks and perform additional playback experiments to determine those acoustic properties that foster individual recognition.

METHODS AND RESULTS

The chuck is a complex call usually consisting of three components in sequence, the "flag," a frequency-modulated component, the "mast," a steeply descending frequency-modulated component, and the "cackle," a low-frequency component (Fig. 1). We performed discriminant function analysis (DFA) to classify 288 chucks from 20 females and cross-validated the original classification using a subset of 80 unselected chucks. Chucks were obtained from the colony at the Unit of Neuroethology, National Institutes of Health. We performed two separate discriminant function analyses, one based on six acoustic features of the whole chuck and another based on six acoustic features of the initial flag element alone. The results of those analyses demonstrate that the acoustic structure of chucks differs across females but with substantial overlap. In the cross-validation test, 46% of the 80 unselected chucks were assigned to the correct female in the whole chuck DFA (expected = 1/20 or 5%). In the DFA based on acoustic measurements of the flag, 58% of the unselected chucks were assigned to the correct female. The acoustic features of the initial flag element of the chuck, in particular the fundamental frequency across the flag and duration of the flag, separated individuals better than the acoustic features of the whole chuck.

Statistical analyses of individual female chucks indicated that the highly variable, frequency-modulated flag component of the chuck distinguishes females. We used playback experiments on adult females (*n* = 16) to determine whether adult females attend to these acoustic properties when engaging in chuck exchanges. Females were housed at the NIH Animal Center in Poolesville, Maryland. Stimuli were played through a speaker to social groups in outdoor enclosures separated from other animals. We played three stimuli in the playbacks: 1) whole chucks from familiar group females, 2) the same chucks with the initial flag component removed, and 3) silent controls. We recorded the identity and vocal response of the first responder within 4 s of the playback stimulus.

The results of playbacks supported the statistical analyses. Adult females were significantly more likely to respond with a chuck to playbacks of familiar chucks than to the same chucks with the initial flag element removed, and females responded to both chuck stimuli significantly more than to silent controls. Females responded with a chuck to 29% of whole chucks, to 23% of flagless chucks, and to 7% of silent control playbacks. Acoustic information primarily in the flags distinguishes the chuck vocalizations of individual female squirrel monkeys, and females use this information to identify callers in antiphonal sequences.
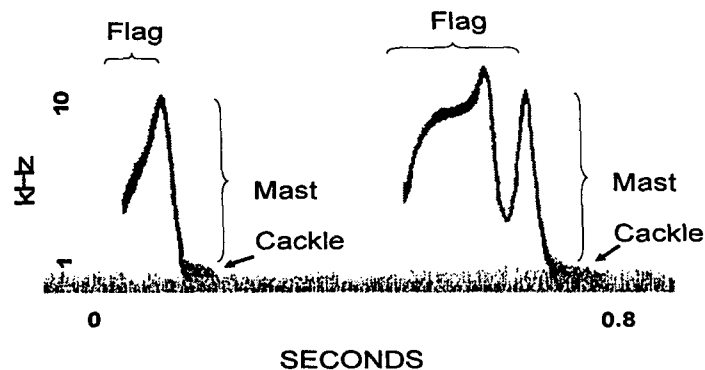
FIGURE 1. Exemplar chucks in a natural exchange between two females.

DISCUSSION

The discriminant function analyses show that the acoustic structure of chucks differs across adult female squirrel monkeys but with substantial overlap. The chuck contains signature information regarding individual identity but does not differ qualitatively across females. In the wild, squirrel monkeys reside in large social groups so the 20 adult female analysis presented here may reflect the discrimination task faced by squirrel monkeys in natural social groups. The statistical analyses and playback experiments suggest that the first flag component, in particular flag duration and peak frequency of the flag, conveys information regarding individual identity. These acoustic properties of chucks disproportionately separated individuals, and females responded to whole chucks more than they responded to the same chucks with the flags removed. The response reduction was only from 29 to 23%, however. This is consistent with earlier playback results, which show that familiar chucks are answered most but that unfamiliar chucks are also answered, and all chuck stimuli are answered more than silent controls. The clearly patterned but nevertheless imperfect discrimination of individual chucks based on familiarity may reflect the substantial overlap in acoustic structure across females. Further work in the wild is needed to determine for natural social groups the extent to which the chucks of females differ and the extent to which they can recognize each other by voice alone.

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